

FORM PTO-1390 (Modified)  
(REV 11-98)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

## TRANSMITTAL LETTER TO THE UNITED STATES

210131US0PCT

DESIGNATED/ELECTED OFFICE (DO/EO/US)

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR

CONCERNING A FILING UNDER 35 U.S.C. 371

09/857214

INTERNATIONAL APPLICATION NO.  
PCT/JP99/05979INTERNATIONAL FILING DATE  
28 OCTOBER 1999PRIORITY DATE CLAIMED  
24 DECEMBER 1998

## TITLE OF INVENTION

CONTAINER FOR IMMUNOLOGIC ASSAY

## APPLICANT(S) FOR DO/EO/US

Hayao TANAKA

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
  - a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
  - b. ☒ has been transmitted by the International Bureau.
  - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ A copy of the International Search Report (PCT/ISA/210).
8. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
  - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
  - b. ☐ have been transmitted by the International Bureau.
  - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
  - d. ☒ have not been made and will not be made.
9. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
10. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
11. ☐ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☒ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

## Items 13 to 20 below concern document(s) or information included:

13. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☐ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ Certificate of Mailing by Express Mail
20. ☒ Other items or information:

## Request for Consideration of Documents Cited in International Search Report

Notice of Priority

PCT/IB/304

PCT/IB/308

Drawings (1 sheet)

Amended Sheet (Page 25A)


U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR <b>09/857214</b>		INTERNATIONAL APPLICATION NO. <b>PCT/JP99/05979</b>		ATTORNEY'S DOCKET NUMBER <b>210131US0PCT</b>	
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21. The following fees are submitted: <b>BASIC NATIONAL FEE ( 37 CFR 1.492 (a) (1) - (5) ) :</b> <input type="checkbox"/> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO ..... <b>\$1,000.00</b> <input checked="" type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO ..... <b>\$860.00</b> <input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO ..... <b>\$710.00</b> <input type="checkbox"/> International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) ..... <b>\$690.00</b> <input type="checkbox"/> International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) ..... <b>\$100.00</b> <b>ENTER APPROPRIATE BASIC FEE AMOUNT =</b>				<b>CALCULATIONS PTO USE ONLY</b>  <div style="border: 1px solid black; height: 100px; width: 100%;"></div>																																																																															
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<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <th style="width:15%;">CLAIMS</th> <th style="width:20%;">NUMBER FILED</th> <th style="width:20%;">NUMBER EXTRA</th> <th style="width:10%;">RATE</th> <th style="width:15%;"></th> <th style="width:10%;"></th> </tr> <tr> <td>Total claims</td> <td>16 - 20 =</td> <td>0</td> <td>x \$18.00</td> <td></td> <td style="text-align: right;"><b>\$0.00</b></td> </tr> <tr> <td>Independent claims</td> <td>1 - 3 =</td> <td>0</td> <td>x \$80.00</td> <td></td> <td style="text-align: right;"><b>\$0.00</b></td> </tr> <tr> <td colspan="4">Multiple Dependent Claims (check if applicable).</td> <td style="text-align: center;"><input checked="" type="checkbox"/></td> <td style="text-align: right;"><b>\$270.00</b></td> </tr> <tr> <td colspan="5" style="text-align: center;"><b>TOTAL OF ABOVE CALCULATIONS =</b></td> <td style="text-align: right;"><b>\$1,130.00</b></td> </tr> <tr> <td colspan="5">                     Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) (check if applicable).                 </td> <td style="text-align: right; vertical-align: bottom;"> <input type="checkbox"/> <b>\$0.00</b> </td> </tr> <tr> <td colspan="5" style="text-align: center;"><b>SUBTOTAL =</b></td> <td style="text-align: right;"><b>\$1,130.00</b></td> </tr> <tr> <td colspan="4">                     Processing fee of <b>\$130.00</b> for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492 (f)).                 </td> <td colspan="2" style="text-align: right; vertical-align: bottom;"> <b>\$0.00</b> </td> </tr> <tr> <td colspan="5" style="text-align: center;"><b>TOTAL NATIONAL FEE =</b></td> <td style="text-align: right;"><b>\$1,130.00</b></td> </tr> <tr> <td colspan="5">                     Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable).                 </td> <td style="text-align: right; vertical-align: bottom;"> <input type="checkbox"/> <b>\$0.00</b> </td> </tr> <tr> <td colspan="5" style="text-align: center;"><b>TOTAL FEES ENCLOSED =</b></td> <td style="text-align: right;"><b>\$1,130.00</b></td> </tr> <tr> <td colspan="5"></td> <td style="text-align: right;"> <b>Amount to be:</b>  <b>refunded</b> \$             </td> </tr> <tr> <td colspan="5"></td> <td style="text-align: right;"> <b>charged</b> \$             </td> </tr> </table>				CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE			Total claims	16 - 20 =	0	x \$18.00		<b>\$0.00</b>	Independent claims	1 - 3 =	0	x \$80.00		<b>\$0.00</b>	Multiple Dependent Claims (check if applicable).				<input checked="" type="checkbox"/>	<b>\$270.00</b>	<b>TOTAL OF ABOVE CALCULATIONS =</b>					<b>\$1,130.00</b>	Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) (check if applicable).					<input type="checkbox"/> <b>\$0.00</b>	<b>SUBTOTAL =</b>					<b>\$1,130.00</b>	Processing fee of <b>\$130.00</b> for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492 (f)).				<b>\$0.00</b>		<b>TOTAL NATIONAL FEE =</b>					<b>\$1,130.00</b>	Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable).					<input type="checkbox"/> <b>\$0.00</b>	<b>TOTAL FEES ENCLOSED =</b>					<b>\$1,130.00</b>						<b>Amount to be:</b> <b>refunded</b> \$						<b>charged</b> \$	<div style="border: 1px solid black; padding: 5px;"> <input checked="" type="checkbox"/> A check in the amount of <b>\$1,130.00</b> to cover the above fees is enclosed.   <input type="checkbox"/> Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees.                      A duplicate copy of this sheet is enclosed.   <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. <b>15-0030</b> A duplicate copy of this sheet is enclosed.                 </div>	
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**NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.**

SEND ALL CORRESPONDENCE TO:



**22850**

Surinder Sachar  
Registration No. 34,423

SIGNATURE

NAME

24,618

REGISTRATION NUMBER

6-22-01

DATE

11/PRTS

09/857214  
JC18 Rec'd PCT/PTO 22 JUN 2001

## Description

### Container for Immunologic Assay

#### Technical Field

The present invention relates to a container used for storage, dilution, or reaction of a reagent and/or a test sample, in an immunoassay for detecting an antigen or an antibody through antigen-antibody reaction.

#### Background Art

Conventional immunoassays employ a polystyrene- or polypropylene-made container for storage and dilution of a reagent or a sample which is to be used. However, molecules contained in the reagent or the sample are non-specifically adsorbed onto such a container, and such adsorption necessarily causes loss of the reagent or the sample, as well as variation in concentration of a solution containing the reagent or the sample.

In recent years, in accordance with diversification of immunoassay methods, in most cases, naturally occurring substances have been used after extraction and purification, particularly in the drug production department of drug manufacturers. Generally speaking, such substances are obtained in very small amounts and thus are quite expensive. Therefore, reduction in the amount of substance during storage or dilution, which is caused by physical adsorption

onto a container, is not negligible.

When samples used for clinical diagnosis, such as serum and urine, are collected from patients, placed in a container, and stored therein until the samples are subjected to assay, clinically important proteins contained in the samples, such as albumin, transferrin, and immunoglobulin, are adsorbed onto the container. Most containers used for clinical diagnosis, including syringes and cups used in the step of collecting a sample, tubes used in the step of storing the sample, and centrifugation tubes and test tubes used in the step of purifying, concentrating, or diluting the sample, are formed from polypropylene or polystyrene, and such a container is not subjected to surface treatment. Therefore, when even a trace amount of proteins contained in the sample is adsorbed onto the container in each step, the concentration of the proteins is expected to vary greatly after all the steps have been performed, as compared with the concentration of the proteins at the time of collection of the sample.

In general, the price of a reagent in immobilized form accounts for about 80% the cost of a clinical test kit sold by a clinical test drug manufacturer. Therefore, when reduction in the reagent due to adsorption onto a container is suppressed, production costs are greatly reduced.

In a solid phase method (a type of immunoassay method), assay is carried out by utilizing proteins immobilized onto the surface of a container for an immunoassay. Therefore, a

solid phase method employs a container subjected to "high adsorption treatment," in which, in order to increase the amount of a reagent which is to be immobilized onto the surface of the container, a hydrophilic-hydrophobic balance of the surface is regulated through introduction of a functional group such as a hydroxyl group, thereby increasing the saturation adsorption amount of the reagent.

In recent years, in order to shorten immunoassay time and to carry out immunoassay on a large scale, immunoassay methods making use of an automatic analyzer (robot) have been developed. Such methods have rapidly become prevalent, particularly in the drug production department of drug manufacturers.

When an assay is carried out by means of a conventional solid phase method, a washing step for eliminating non-immobilized excess molecules is required. However, an automatic analyzer encounters difficulty in carrying out the washing step, in which fractional injection and suction of a washing solution are repeated. Therefore, a sequential addition method has been under development as an immunoassay method suitable for an automatic analyzer, because such a method does not require separation of a reacted substance and a non-reacted substance through a washing step.

In a sequential addition method, immobilization of molecules is not carried out during reaction, and reaction is carried out in a solution. Therefore, when a container having a surface subjected to the aforementioned high

adsorption treatment is used, unwanted adsorption of the molecules impedes reaction in the solution or lowers the reaction efficiency.

In recent years, in accordance with progress in measurement techniques, evaluations through a fluorescence method or an emission method have been established, the method having high sensitivity as compared with absorbance assay by means of a conventional colorimetric method. Therefore, in the future, unwanted adsorption of molecules onto a container is expected to induce problems in such an assay method having high sensitivity.

At the present time, a container used for such a method is provided without consideration of molecular adsorption; i.e., the container is formed from polystyrene or polypropylene in consideration of only shapability, transparency, and low-temperature resistance, and the container is not subjected to surface treatment for suppressing adsorption of molecules. From the viewpoint of characteristics of the container, no attempt has been made to solve problems such as loss of a reagent and reduction in sensitivity.

However, in order to control non-specific adsorption of molecules onto the surface of a container for immunoassays, several techniques have hitherto been studied and carried out.

For example, a blocking method is most widely carried out, in which a container is coated with a protein inactive to a sample which is to be assayed. Since the method

basically utilizes non-specific adsorption of the protein onto the container, blocking effects may differ from container to container, and may depend on the state of the protein. In addition, since the inactive protein is non-specifically adsorbed onto the container, the protein is easily detached from the container into a solution, and thus the container cannot be used for storing the solution. Japanese Patent Application Laid-Open (*kokai*) Nos. 6-174726 and 7-128336 disclose a technique in which such detachment of a protein is eliminated by chemically immobilizing the protein onto a container. However, the structure of the protein may vary in accordance with drying temperature, storage temperature, and storage time, and thus the container is not widely used in practice.

When the higher-order structure of a protein adsorbed onto a container varies, the protein induces secondary adsorption. When a protein which is inactive in a free state is adsorbed onto or chemically bound to a container, the protein cannot completely maintain its inactive state, due to alteration of the higher-order structure. Therefore, even when adsorption of another protein onto the container can be prevented, variance of the higher-order structure induces secondary adsorption between the proteins.

Secondary adsorption between proteins varies with types of proteins, and thus a protein suitable for blocking must be chosen every time a sample which is to be assayed is changed. When a solution containing different proteins, such as serum,

is used as a sample, no blocking protein can control adsorption of all the proteins contained in the sample.

#### Disclosure of the Invention

In view of the foregoing, the present inventors have performed extensive studies on characteristics of a container, and have found that when the saturation amount of molecules which are adsorbed onto the container, the molecules being used for an immunoassay, is controlled to a predetermined value or less, loss of a reagent or a sample is prevented during storage, dilution, and reaction, and the sample can be assayed at high sensitivity. The present invention has been accomplished on the basis of this finding.

Accordingly, the present invention provides a container for an immunoassay in which the saturation adsorption amount of molecules used for the assay is  $1 \times 10^{-1}$  pmol/cm<sup>2</sup> or less.

#### Brief Description of Drawings

Fig. 1 shows the concentration of proteins after bovine serum and albumin have been stored in the container for an immunoassay of the present invention at -80°C for 48 hours. Fig. 2 shows reaction efficiency when an immunoassay is carried out in the container of the present invention.

#### Best Mode for Carrying Out the Invention

In a conventional polystyrene- or polypropylene-made container for an immunoassay, the adsorption amount of

molecules (e.g., proteins) is about 1-10 pmol/cm<sup>2</sup> or more; i.e., about 20-50% of molecules (e.g., proteins) used for an immunoassay are adsorbed onto the container, although the adsorption amount varies in accordance with the concentration of a solution containing such molecules and the contact area between the molecules and the container. When the adsorbed molecules (20-50% of all the molecules) are essential for reaction in the solution, reaction efficiency; i.e., assay sensitivity, is reduced by 20-50%. Meanwhile, when the adsorbed substance is such that it undergoes molecular structural changes due to adsorption to thereby cause unwanted reaction, considerable noise would result.

Therefore, a container onto which no molecules used for an immunoassay are adsorbed is most ideal, but when the adsorption amount of molecules is substantially reduced to 1/10-1/100 with respect to the current level, satisfactory effects will be obtained.

Although the adsorption amount of molecules contained in a solution varies with the identity of the molecules, temperature, concentration of the solution, and the pH of the solvent, the container desirably meets the following conditions: the saturation adsorption amount of the molecules used in the immunoassay is  $1 \times 10^{-1}$  pmol/cm<sup>2</sup> or less under the specific conditions—in terms of concentration of the solution, temperature, and pH of the solvent—under which the reaction and assay are carried out. In the case in which serum is used for an immunoassay, since serum is usually

diluted up to 1/10, the effect of the invention can be attained if the saturation adsorption amount of the molecules which participate in and/or affect the assay, among all molecules contained in the diluted serum, is always  $1 \times 10^{-1}$  pmol/cm<sup>2</sup> or less at the diluted concentration of serum and under the specific conditions—in terms of concentration of the solution, temperature, and pH of the solvent—under which the reaction and assay are carried out.

Similarly, when the container is used for storage and dilution of a reagent, the effect of the invention can be attained if the saturation adsorption amount of the molecules that undergo storage and dilution is always  $1 \times 10^{-1}$  pmol/cm<sup>2</sup> or less under the specific conditions—in terms of concentration of the solution, temperature, and pH of the solvent—under which the reagent is removed from the storage container or dilution is carried out. In many cases, the reagent is stored in the container at a temperature as low as -80°C. However, adsorption of the molecules is an equilibrium reaction, and thus, it would be sufficient if the saturation adsorption amount of molecules is  $1 \times 10^{-1}$  pmol/cm<sup>2</sup> or less under the specific conditions—in terms of concentration, temperature, and pH—under which the reagent is removed from the container.

The saturation adsorption amount of the molecules is more preferably  $1 \times 10^{-2}$  pmol/cm<sup>2</sup> or less, much more preferably  $1 \times 10^{-3}$  pmol/cm<sup>2</sup> or less.

Examples of the molecules used in an immunoassay

include proteins (e.g., enzymes, physiologically active proteins, and antibodies), nucleic acids, and physiologically active substances. Of these, proteins are particularly preferable. The saturation adsorption amount of the molecules can be measured by means of colloidal gold labeling immunoassay.

In the point that adsorption of a protein is prevented, the present invention exerts excellent effects in addition to the aforementioned characteristic feature. Usually, when a protein is adsorbed onto a container, the structure of the protein is varied. Therefore, when an immunoassay is carried out, although a target protein is contained in a sample to be assayed, the protein may fail to be detected by an antibody, due to variation in the structure of the protein. When a clinical test is carried out, in practice serum whose structure has been altered due to adsorption is assayed, even though serum must be assayed in the same state in which the serum is present in an organism. According to the present invention, since a protein is not adsorbed onto the container, the structure of the protein is not altered, and thus when a clinical test is carried out by use of the container, serum can be assayed in a state similar to that in which serum is present in an organism. Therefore, the container of the present invention is very advantageously used as a container for an immunoassay.

In a container for an immunoassay, the saturation adsorption amount of molecules must be decreased at a portion

with which a reagent or a sample is brought into contact; specifically, an inner surface of the container. Therefore, the molecular saturation adsorption amount at an inner surface of the container should be at least  $1 \times 10^{-1}$  pmol/cm<sup>2</sup> or less.

In order to decrease the saturation adsorption amount of molecules at an inner surface of the container to  $1 \times 10^{-1}$  pmol/cm<sup>2</sup> or less, preferably, at least the inner surface is formed from a highly hydrophilic polymer or a highly hydrophobic polymer, or is coated with a highly hydrophilic polymer or a highly hydrophobic polymer. More preferably, at least the inner surface is coated with a highly hydrophilic polymer or a highly hydrophobic polymer. Much more preferably, at least the inner surface is coated with a highly hydrophilic polymer. Particularly preferably, at least the inner surface is coated with an ultra-hydrophilic polymer.

Examples of highly hydrophobic polymers include fluorine-containing resins such as polytetrafluoroethylene (PTFE) and silicon-containing resins. When the surface of the container is coated with a hydrophobic polymer, the surface may be coated with the aforementioned hydrophobic polymer, or the container may be fluorinated, thereby forming a fluorinated polymer film on the surface thereof.

No particular limitation is imposed on the highly hydrophilic polymer, so long as the polymer contains a hydrophilic group such as a carboxyl group or a hydroxyl

group. Examples of such a hydrophilic polymer include polymethacrylic acid, (meth)methacrylic acid-alkyl methacrylate copolymers, polyhydroxyalkyl methacrylates (e.g., polyhydroxyethyl methacrylate), hydroxyalkyl methacrylate-alkyl methacrylate copolymers, polyoxyalkylene-group-containing methacrylate polymer and copolymers containing the polymer, polyvinyl pyrrolidone, ethylene-vinyl alcohol copolymers, (2-methacryloyloxyethylphosphocholine) polymers (MPC) and copolymers containing the polymers (Seitai Zairyo, Vol. 9, No. 6, 1991), and phospholipid-polymer composites (Japanese Patent Application Laid-Open (*kokai*) Nos. 5-161491 and 6-46831). The container may be formed from such a hydrophilic polymer, or coated with the polymer.

After the container is formed from a suitable material, such as polystyrene, a hydroxyl group or a carboxyl group may be introduced into the surface of the container, to thereby impart high hydrophilicity; i.e., low adsorbability, to the surface of the container. A surface exhibiting low adsorbability can be realized by means of surface modification. For example, when, in consideration of formability, the container is formed from a material which tends to induce non-specific adsorption, such as polystyrene or polypropylene, a carboxyl group, a carbonyl group, and/or a hydroxyl group may be introduced into the surface of the container through plasma exposure, to thereby impart low adsorbability to the surface. When, in consideration of transparency, the container is formed from polymethyl

methacrylate, a carboxyl group may be introduced into the surface of the container through partial hydrolysis of the surface by use of an alkali, to thereby impart low adsorbability to the surface.

When hydrophilicity is imparted to the inner surface of the container by use of a hydrophilic polymer, to thereby reduce the adsorption amount of molecules, the contact angle between the surface and water is preferably 30° or less (highly hydrophilic), more preferably 15° or less, much more preferably 1° or less (ultra-hydrophilic).

When, among the aforementioned hydrophilic polymers, there is employed a polyhydroxyalkyl methacrylate, a polyoxy(C<sub>2</sub>-C<sub>4</sub> alkylene-group-containing methacrylate) polymer or a copolymer containing the polymer; a (2-methacryloyloxyethylphosphocholine) polymer or a copolymer containing the polymer; a phospholipid-polymer composite; or polyvinyl pyrrolidone, the contact angle between the surface of the resultant container and water becomes 1° or less (i.e., the container is ultra-hydrophilic), and the saturation adsorption amount of proteins becomes  $1 \times 10^{-3}$  pmol/cm<sup>2</sup> or less, which is particularly preferable.

The product form of the container of the present invention is not particularly limited, and the container may assume conventionally used product forms, including a sample tube, a centrifugation tube, a multi-well plate, and a cuvette. However, in order to carry out storage, dilution, reaction, and assay of a sample in one container, the

container preferably assumes a form of multi-well plate.

### Examples

The present invention will next be described in more detail by way of Examples, which should not be construed as limiting the invention thereto.

#### (Example 1)

A commercially available polypropylene-made 96-well plate (MS-3396P, product of Sumitomo Bakelite Co., Ltd.) was subjected to  $\gamma$ -ray treatment at 70 kGy, to thereby generate a hydroxyl group on the surface of the plate. In the resultant plate, the saturation adsorption amount of proteins was  $4.6 \times 10^{-2}$  pmol/cm<sup>2</sup>, and the contact angle between the surface and the water was 27°.

#### (Example 2)

A commercially available polypropylene-made 96-well plate (MS-3396P, product of Sumitomo Bakelite Co., Ltd.) was coated with a commercially available fluorine-containing coating agent (Scotchguard, product of Sumitomo 3M Ltd.). In the resultant plate, the saturation adsorption amount of proteins was  $2.7 \times 10^{-2}$  pmol/cm<sup>2</sup>, and the contact angle between the surface and the water was 126°.

#### (Comparative Example 1)

A commercially available polypropylene-made 96-well plate (MS-3396P, product of Sumitomo Bakelite Co., Ltd.) was used as a comparative plate. In the plate, the saturation adsorption amount of proteins was 3.7 pmol/cm<sup>2</sup>, and the

contact angle between the surface and the water was 92°.

(Comparison of protein recovery percentage in containers usable as storage containers)

For comparison of non-specific adsorption, solutions of an enzyme-labeled anti-bovine-albumin antibody (product of Cosmo Bio) were prepared (concentration of the antibody: 0.1 ng/mL, 1 ng/mL, 10 ng/mL, and 100 ng/mL, respectively); each solution was injected into 24 wells of each of the plates of Examples 1 and 2 and Comparative Example 1; the plate was stored at -80°C for 48 hours; and after storage time had elapsed, the concentration of the protein in each solution was measured by use of a substrate solution.

The results are shown in Fig. 1. The results show that the protein recovery percentage is high in the plates of Examples 1 and 2, as compared with the case of the plate of Comparative Example 1.

(Comparison of "in solution" reaction efficiency)

In order to evaluate the efficiency of a reaction in a solution, the following test was carried out by using the plates of Examples 1 and 2 and Comparative Example 1 as reaction containers.

Rat albumin (product of Cosmo Bio) was dissolved in a phosphate buffer (Dulbecco PBS pH 7.4) to thereby prepare solutions (concentration of the albumin: 10 ng/mL, 1 ng/mL, and 0.1 ng/mL, respectively), and each solution was injected into four lines (i.e., 32 wells) (100  $\mu$ l per well) of each of the plates of Examples 1 and 2 and Comparative Example 1.

Subsequently, a phosphate buffer (Dulbecco PBS pH 7.4) solution of a peroxidase-labeled anti-rat-albumin antibody (product of Cosmo Bio) (concentration of the antibody: 100 ng/mL, respectively) was injected into all the wells (100  $\mu$ l per well) of each plate.

After reaction had been carried out in each well at 37°C for 30 minutes, the solution in each well was transferred into a 96-well plate for ELISA in which an anti-rat-albumin antibody had been immobilized onto each well in advance, and then reaction was carried out again in each well at 37°C for 30 minutes.

After reaction was completed, a non-reacted peroxidase-labeled anti-rat-albumin antibody was washed with a washing solution (Dulbecco PBS pH 7.4 + 0.05% Tween 20).

Subsequently, each plate was allowed to develop color by use of a commercially available chromophoric kit for peroxidase (ML-1120T, product of Sumitomo Bakelite Co., Ltd.), and then absorbance at 450 nm was measured using a plate reader.

The results are shown in Fig. 2. The results show that, in relation to the plate of Comparative Example 1, the absorbance is low when the concentration of the albumin is low; i.e., the reaction in the solution is impeded due to adsorption, and that, in relation to the plates of Examples 1 and 2, linearity is obtained between the concentration of the albumin and the absorbance when the albumin concentration is low; i.e., the antigen-antibody reaction in the solution is efficiently carried out.

(Example 3)

A commercially available polystyrene-made tube (Eiken tube for RIA No. 3, 70-12458) was coated with polyhydroxyethyl methacrylate (P-3932, product of SIGMA). In the resultant tube, the saturation adsorption amount of proteins was  $9.1 \times 10^{-4}$  pmol/cm<sup>2</sup>, and the contact angle between the surface and the water was 0°.

(Example 4)

Polytetrafluoroethylene was formed into a tube of the same inner diameter and volume as the tube of Example 1. In the resultant tube, the saturation adsorption amount of proteins was  $7.2 \times 10^{-3}$  pmol/cm<sup>2</sup>, and the contact angle between the surface and the water was 126°.

(Comparative Example 2)

A commercially available polystyrene-made tube (Eiken tube for RIA No. 3, 70-12458) was used as a comparative tube. In the tube, the saturation adsorption amount of proteins was 8.1 pmol/cm<sup>2</sup>, and the contact angle between the surface and the water was 85°.

(Comparison of assay sensitivity)

In order to evaluate the assay sensitivity of a reaction in a solution, the following test was carried out by use of the tubes of Examples 3 and 4 and Comparative Example 2 as reaction containers and an ELISA ball as a carrier for reaction.

Phosphate buffer (pH 7.4) solutions of biotin hydrazide (product of Dojindo) were prepared in advance (concentration

of biotin hydrazide: 0.125 µg/mL, 0.250 µg/mL, and 0.500 µg/mL, respectively). By use of the solutions, biotin hydrazide was immobilized onto ELISA balls (amino-group-containing ball, product of Sumitomo Bakelite Co., Ltd.) through covalent bonding via glutaraldehyde, to thereby prepare ELISA balls having three different immobilization densities of biotin hydrazide.

A portion of each ELISA ball at which biotin hydrazide was not immobilized was subjected to blocking by use of skim milk so as to prevent adsorption.

Each of the above-prepared ELISA balls was placed into each of the tubes of Example 3, Example 4, and Comparative Example 2 (three tubes for each Example), a phosphate buffer (pH 7.4) solution of peroxylase-labeled avidin (product of Cappel) (concentration of avidin: 1 µg/mL) was injected into each tube (500 mL per tube), and reaction was carried out in each tube at room temperature for 30 minutes.

After the reaction was completed, non-reacted peroxylase-labeled avidin was washed with a washing solution (phosphate buffer pH 7.4 + 0.05% Tween 20). Subsequently, each ELISA ball was allowed to develop color by use of a commercially available chromophoric kit for peroxidase (ML-1120T, product of Sumitomo Bakelite Co., Ltd.), and then absorbance at 450 nm was measured by using a plate reader.

The results are shown in Table 1. The results show that, in Examples 3 and 4, the absorbance varies linearly with respect to the density of biotin hydrazide introduced onto

the surface of the ELISA ball, and that, in Comparative Example 2, the absorbance does not vary with the different densities of biotin hydrazide.

In Examples 3 and 4, peroxylase-labeled avidin is reacted with only biotin hydrazide introduced onto the surface of the ELISA ball, and thus the absorbance is proportional to the density of biotin hydrazide. In contrast, in Comparative Example 2, peroxylase-labeled avidin remains in the tube due to adsorption, and the remaining avidin may act as a background, to thereby reduce assay sensitivity.

Table 1

Biotin-avidin reaction by use of ELISA ball

$\mu\text{g/mL}$	Example 3	Example 4	Comparative Example 2
0.125	0.2	0.27	1.05
0.25	0.54	0.62	1.03
0.5	0.97	0.91	1.12

(Comparison of protein recovery percentage in containers usable as storage containers)

For comparison of non-specific adsorption, solutions of an enzyme-labeled anti-bovine-albumin antibody (product of Cosmo Bio) were prepared (concentration of the antibody: 0.1 ng/mL, 1 ng/mL, 10 ng/mL, and 100 ng/mL, respectively); each solution was injected into 24 wells of each of the plate of Example 3, the plate of Example 4, and the plate of Comparative Example 2; the plates were stored at  $-80^{\circ}\text{C}$  for 48 hours; and after storage time had elapsed, the concentration of the protein in each solution was measured by use of a

substrate solution.

The results are shown in Table 2. The results show that the protein recovery percentage is high in the plates of Examples 3 and 4, as compared with in the plate of Comparative Example 2.

Table 2  
Protein concentration after storage  
(comparison of absorbance)

ng/mL	Example 3	Example 4	Comparative Example 2
0.1	0.24	0.26	0.01
1	0.41	0.33	0.07
10	0.76	0.66	0.07
100	1.02	0.82	0.03

(Example 5)

A 2.0 wt/vol% methanol solution of polyhydroxyethyl methacrylate (P-3932, product of SIGMA) (2.5 mL) was injected into a commercially available polystyrene-made tube (Eiken tube for RIA No. 3, 70-12458). Subsequently, the solution was removed from the tube, the tube was inverted so as to prevent the residual solution from remaining at the bottom, and the tube was dried at room temperature for 24 hours, and consequently the surface of the tube was coated with polyhydroxyethyl methacrylate. In the resultant tube, the saturation adsorption amount of proteins is  $8.7 \times 10^{-4}$  pmol/cm<sup>2</sup>, and the contact angle between the surface and water is 0°.

(Example 6)

A 0.5 wt/vol% ethanol solution of an MPC polymer (2.5 mL) was injected into a commercially available polystyrene-

made tube (Eiken tube for RIA No. 3, 70-12458), and the tube was allowed to stand at room temperature for 10 minutes. Subsequently, the solution was removed from the tube, the tube was inverted so as to prevent the residual solution from remaining at the bottom, and the tube was dried at room temperature overnight, and consequently the surface of the tube was coated with the MPC polymer. In the resultant tube, the saturation adsorption amount of proteins is  $6.5 \times 10^{-4}$  pmol/cm<sup>2</sup>, and the contact angle between the surface and water is 0°.

The MPC polymer was synthesized from an MPC-BMA (butyl methacrylate) copolymer (ratio of MPC to BMA = 3/7) which was prepared according to the procedure described in "Release of a drug from a hydrogel membrane having a structure analogous to that of phospholipid," (Kobunshi Ronbunshu, 46, 591-595 (1989)).

(Comparative Example 3)

A commercially available polystyrene-made tube (Eiken tube for RIA No. 3, 70-12458) was used in "as is" form as a comparative tube.

(Comparison of assay sensitivity)

In order to evaluate the assay sensitivity of a reaction in a solution, the following test was carried out by use of the tubes of Examples 5 and 6 and Comparative Example 3 as reaction containers, and an ELISA ball (amino-group-containing ball, product of Sumitomo Bakelite Co., Ltd.) as a carrier for reaction.

Phosphate buffer (pH 7.4) solutions of biotin hydrazide (product of Dojindo) were prepared in advance (concentration of biotin hydrazide: 0.125 µg/mL, 0.250 µg/mL, and 0.500 µg/mL). By use of the solutions, biotin hydrazide was immobilized onto ELISA balls through covalent bonding via glutaraldehyde, to thereby prepare ELISA balls having three different immobilization densities of biotin hydrazide.

A portion of each ELISA ball at which biotin hydrazide was not immobilized was subjected to blocking by use of skim milk so as to prevent adsorption.

Each of the above-prepared ELISA balls was placed into the tubes of Example 5, Example 6, and Comparative Example 3 (three tubes for each Example), a phosphate buffer (pH 7.4) solution of peroxylase-labeled avidin (product of Cappel) (concentration of avidin: 1 µg/mL) was injected into each tube (500 µL per tube), and reaction was carried out at room temperature for 30 minutes.

After the reaction was completed, non-reacted peroxylase-labeled avidin was washed with a washing solution (phosphate buffer pH 7.4 + 0.05% Tween 20). Subsequently, each ELISA ball was allowed to develop color by use of a commercially available chromophoric kit for peroxidase (ML-1120T, product of Sumitomo Bakelite Co., Ltd.), and then subjected to measurement of absorbance at 450 nm by use of a plate reader.

The results are shown in Table 3. The results show that, in Examples 5 and 6, the absorbance varies linearly with

respect to the density of biotin hydrazide introduced onto the surface of the ELISA ball, and that, in Comparative Example 3, the absorbance does not vary with the different densities of biotin hydrazide.

In Examples 5 and 6, peroxydase-labeled avidin is reacted with only biotin hydrazide introduced onto the surface of the ELISA ball, and thus the absorbance is proportional to the density of biotin hydrazide. In contrast, in Comparative Example 3, peroxydase-labeled avidin remains in the tube due to adsorption, and the remaining avidin may act as a background, to thereby lower assay sensitivity.

Table 3

Biotin-avidin reaction by use of ELISA ball

$\mu\text{g/mL}$	Example 5	Example 6	Comparative Example 3
0.125	0.22	0.14	1.32
0.25	0.56	0.64	1.36
0.5	1.12	1.27	1.39

(Comparison of protein recovery percentage in containers usable as storage containers)

For comparison of non-specific adsorption, solutions of an enzyme-labeled anti-bovine-albumin antibody (product of Cosmo Bio) were prepared (concentration of the antibody: 0.1 ng/mL, 1 ng/mL, 10 ng/mL, and 100 ng/mL); each solution was injected into 24 wells of each plate; the plates were stored at  $-80^{\circ}\text{C}$  for 48 hours; and after storage was completed, the concentration of the protein in each solution was measured by use of a substrate solution.

The results are shown in Table 4. The results show that the protein recovery percentage is high in the plates of Examples 5 and 6, as compared with the plate of Comparative Example 3.

Table 4  
Protein concentration after storage  
(comparison of absorbance)

ng/mL	Example 5	Example 6	Comparative Example 3
0.1	0.18	0.21	0.03
1	0.58	0.78	0.02
10	1.01	1.36	0.03
100	1.63	1.87	0.05

### Industrial Applicability

In the container for an immunoassay of the present invention, the adsorption amount of molecules or serum used for the assay is  $1 \times 10^{-1}$  pmol/cm<sup>2</sup> or less, and thus loss of a reagent, which is caused by adsorption, is prevented during storage or dilution of the reagent. Therefore, when the container is used for a liquid-phase reaction, an assay can be carried out at high sensitivity and high accuracy, since there is prevented decrease in reaction efficiency, which is caused by adsorption of molecules to be assayed, or impediment of reaction due to adsorption of unwanted molecules.

When the container is used for a clinical test employing serum, the test can be carried out under conditions similar to those inside the body of an organism, since variation of the structure of serum components, which is caused by adsorption, does not occur in the container.

## Claims

1. A container for an immunoassay in which the saturation adsorption amount of molecules used for the assay is  $1 \times 10^{-1}$  pmol/cm<sup>2</sup> or less.

2. A container for an immunoassay according to claim 1, wherein at least an inner surface of the container is formed from or coated with a highly hydrophilic polymer or a highly hydrophobic polymer.

3. A container for an immunoassay according to claim 1, wherein at least an inner surface of the container is formed from or coated with a highly hydrophilic polymer.

4. A container for an immunoassay according to claim 3, wherein the contact angle between the inner surface of the container and water is 30° or less.

5. A container for an immunoassay according to claim 3, wherein the contact angle between the inner surface of the container and water is 15° or less.

6. A container for an immunoassay according to claim 3, wherein the contact angle between the inner surface of the container and water is 1° or less.

7. A container for an immunoassay according to any one of claims 1 through 6, wherein the saturation adsorption amount of molecules used for the assay is  $1 \times 10^{-3}$  pmol/cm<sup>2</sup> or less.

8. A container for an immunoassay according to any one of claims 3 through 7, wherein at least an inner surface of the container is coated with an ultra-hydrophilic polymer.

9. A container for an immunoassay according to claim 8, wherein the ultra-hydrophilic polymer is selected from among a polyhydroxyalkyl methacrylate, a polyoxy(C<sub>2</sub>-C<sub>4</sub> alkylene-group-containing methacrylate) polymer or a copolymer containing the polymer, polyvinyl pyrrolidone, and a phospholipid-polymer composite.

10. A container for an immunoassay according to claim 8, wherein the ultra-hydrophilic polymer is a (2-methacryloyloxyethylphosphorylcholine) polymer or a copolymer containing the polymer.

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11. (added) A container for an immunoassay according to any one of claims 2 through 8, wherein the highly hydrophilic polymer or the ultra-hydrophilic polymer is insoluble in water.

## Abstract

A container for an immunologic assay in which the saturation adsorption of molecules for use in the assay is  $1 \times 10^{-1}$  pmol/cm<sup>2</sup> or lower. The container is free from non-specific adsorption causative of reagent loss, sensitivity decrease, and precision decrease.

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SHEET 1 OF 1

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Fig. 1

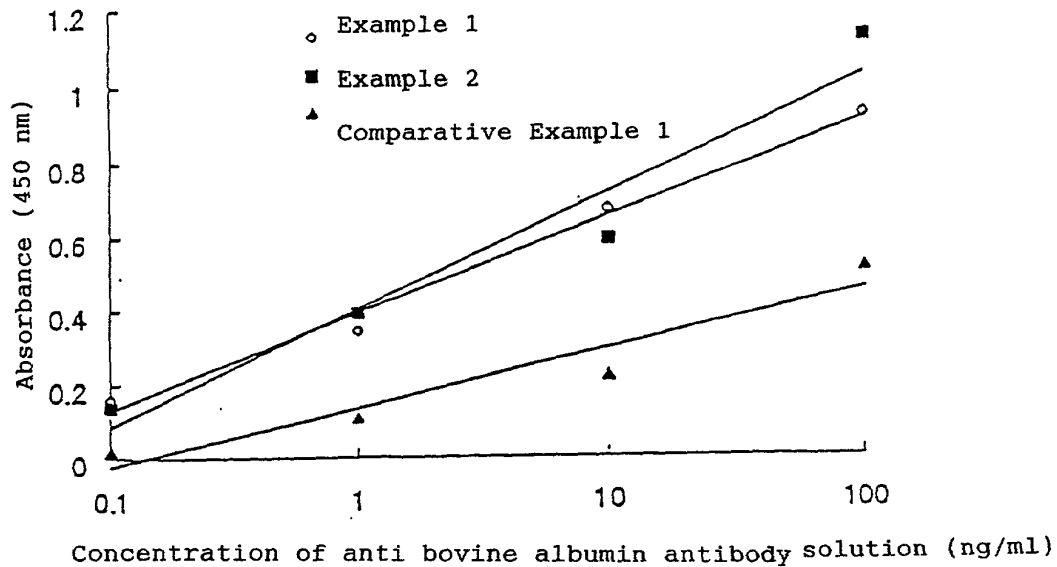
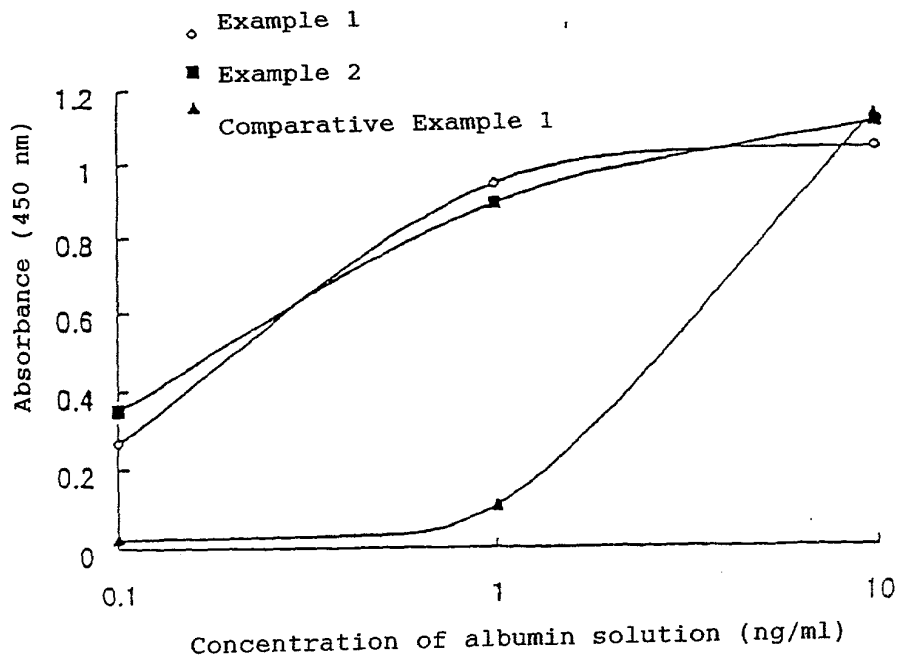


Fig. 2



## Declaration and Power of Attorney For Patent Application

## 特許出願宣言書及び委任状

## Japanese Language Declaration

## 日本語宣言書

下記の氏名の発明者として、私は以下の通り宣言します。

As a below named inventor, I hereby declare that:

私の住所、私書箱、国籍は下記の私の氏名の後に記載された通りです。

My residence, post office address and citizenship are as stated next to my name.

下記の名称の発明に関して請求範囲に記載され、特許出願している発明内容について、私が最初かつ唯一の発明者（下記の氏名が一つの場合）もしくは最初かつ共同発明者（下記の名称が複数の場合）であると信じています。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled.

免疫分析用容器

CONTAINER FOR IMMUNOLOGIC ASSAY

上記発明の明細書は、

☐ 本書に添付されています。

☒ 1999年10月28日に提出され、米国出願番号または特許協定条約国際出願番号を PCT/JP99/05979 とし、

(該当する場合) \_\_\_\_\_ に訂正されました。

the specification of which

☐ is attached hereto.

☒ was filed on October 28, 1999

as ~~United States Application Number~~

PCT International Application Number

PCT/JP99/05979

and was amended on

\_\_\_\_\_ (if applicable).

私は、特許請求範囲を含む上記訂正後の明細書を検討し、内容を理解していることをここに表明します。

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

私は、連邦規則法典第37編第1条56項に定義されるとおり、特許資格の有無について重要な情報を開示する義務があることを認めます。

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

# Japanese Language Declaration

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私は、米国法典第35編119条 (a) - (d) 項又は365条 (b) 項に基づき下記の、米国以外の国の少なくとも一カ国を指定している特許協力条約365 (a) 項に基づく国際出願、又は外国での特許出願もしくは発明者証の出願についての外国優先権をここに主張するとともに、優先権を主張している、本出願の前に出願された特許または発明者証の外国出願を以下に、枠内をマークすることで、示しています。

Prior Foreign Application(s)

外国での先行出願

1998-367404	JAPAN
1999-056253	JAPAN
1999-212096	JAPAN

(NUMBER)

番号

(COUNTRY)

国名

I hereby claim foreign priority under Title 35, United States Code, Section 119 (a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or Section 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Priority Claimed

優先権主張

24/12/1998

03/03/1999

27/07/1999

☒

☐

☒

☐

☒

☐

YES

はい

NO

いいえ

(DAY/MONTH/YEAR FILED)

出願年月日

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(Application No.)

(出願番号)

(Filing Date)

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I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below.

(Application No.)

(出願番号)

(Filing Date)

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I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s), or Section 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code Section 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of application.

(Status: Patented, Pending, Abandoned)

(現況：特許許可済、係属中、放棄済)

(Status: Patented, Pending, Abandoned)

(現況：特許許可済、係属中、放棄済)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Japanese Language Declaration  
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(弁理士、または代理人の指名及び登録番号を明記のこと)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: (list name and registration number)

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国籍		Citizenship	
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